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(71) Applicant(s)

**The Procter & Gamble Company**

**(Incorporated in USA - Ohio)**

**One Procter & Gamble Plaza, Cincinnati, Ohio 45202,  
United States of America**

(72) Inventor(s)

**Rodney Mahlon Wise**

**Stephen Wayne Heinzman**

(74) Agent and/or Address for Service

**Tony Nicholas Gibson**

**Procter & Gamble Limited, P O Box Forest Hall No 2,  
Whitley Road, Longbenton, NEWCASTLE UPON  
TYNE, NE12 9TS, United Kingdom**

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(54) **Stable thickened liquid or gel cleaning composition containing bleach**

(57) Liquid or gel cleaning compositions displaying enhanced physical stability in the presence of bleach are provided, comprising a chlorine bleach ingredient, cross-linked polycarboxylate polymer, a benzene or naphthalene sulfonate rheology stabilizing agent, water and a buffering agent to maintain the pH of the composition above about 10. Preferred automatic dishwashing detergent compositions containing builder and optional surfactant and metalate, and displaying shear thinning behavior, are also disclosed. The benzene or naphthalene sulphonate may be ring substituted by SO<sub>3</sub><sup>-</sup>M<sup>+</sup>, NO<sub>2</sub><sup>-</sup>, -OCH<sub>3</sub> or methy, ethyl, propyl, or isobutyl.

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STABLE THICKENED LIQUID OR GEL CLEANING  
COMPOSITION CONTAINING BLEACH

Rodney Mahlon Wise

Stephen Wayne Heinzman

Technical Field

10 This invention relates to liquid or gel cleaning compositions incorporating a chlorine bleach ingredient, cross-linked polycarboxylate polymers, a rheology stabilizing agent, water and a buffering agent. These compositions display enhanced physical stability in the presence of bleach. One particular application relates to an automatic dishwashing detergent composition  
15 additionally containing builder and optional surfactant and metalate, and exhibiting shear thinning behavior, i.e., high viscosity at low rates of shear and lower viscosities at high rates of shear.

Background of the Invention

20 Thickened aqueous cleaning compositions are known, having been taught in U.S. Pat. Nos. 3,843,548; 3,558,496; 3,684,722; 4,005,027; and 4,116,851.

25 The use of bleaches in cleaning housewares is known, having been taught in U.S. Pat. Nos. 3,928,065; 3,708,429; 3,058,917; and 3,671,440.

30 The use of polycarboxylate polymers in cleaning compositions is known, as disclosed in U.S. Pat. Nos. 3,060,124; 3,671,440; 4,392,977; 4,147,650; 4,836,948 and 5,169,552; U.K. Pat. No. 1527706; and U.K. Pat. Application No. 2203163A.

35 The use of benzene sulfonate derivatives, primarily as a hydrotrope in cleaning compositions, is known, as taught in U.S. Pat. Nos. 5,057,237; 4,900,467; 4,842,771; 4,836,946; 4,801,395; and 4,783,283.

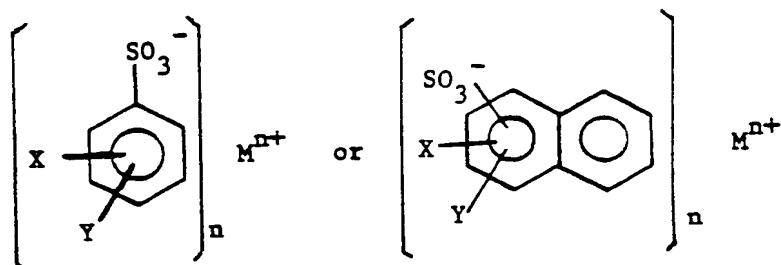
However, none of the above patents discloses applicant's compositions containing a cross-linked polycarboxylate polymer, a

chlorine bleach ingredient, a rheology stabilizer, and a buffering agent.

# Summary of the Invention

The compositions of this invention are liquid or gel cleaning compositions comprising, by weight:

- (a) a chlorine bleach ingredient providing from about 0.2 to 2.5% available chlorine;
- (b) from about 0.1 to 10% of a cross-linked polycarboxylate polymer thickening agent;
- (c) from about 0.05 to 5% of a rheology stabilizing agent having the formula



wherein each X and Y is selected from the group consisting of -H, -Cl, -Br, -SO<sub>3</sub><sup>-</sup>M<sup>+</sup>, -NO<sub>2</sub>, -OCH<sub>3</sub>, -CH<sub>3</sub>, -CH<sub>2</sub>CH<sub>3</sub>, -CH<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>, and -C(CH<sub>3</sub>)<sub>3</sub>, and mixtures thereof; M is selected from the group consisting of H, an alkali metal, an alkaline earth metal, and mixtures thereof; and n is 1 when M is H or an alkali metal, and n is 2 when M is an alkaline earth metal;

- (d) at least about 5% water; and
- (e) sufficient alkalinity buffering agent to provide said composition with a pH greater than about 10.

A particularly preferred embodiment of this invention is an automatic dishwashing detergent composition further comprising:

- (a) from 0% to about 5% of a detergent surfactant;
- (b) from about 5 to 50% of a detergency builder material; and
- (c) from 0% to about 1% of an alkali metal salt of an amphoteric metal anion.

### Detailed Description of the Invention

The compositions of the present invention comprise five essential ingredients: a chlorine bleach ingredient, a cross-linked polycarboxylate polymer thickening agent, a benzene or naphthalene sulfonate rheology stabilizing agent, water, and an alkalinity buffering agent.

#### Chlorine Bleach Ingredient

10 The instant compositions include a bleach ingredient which yields a hypochlorite species in aqueous solution. The hypochlorite ion is chemically represented by the formula  $\text{OCl}^-$ . The hypochlorite ion is a strong oxidizing agent, and materials which yield this species are considered to be powerful bleaching agents.

15 The strength of an aqueous solution containing hypochlorite ion is measured in terms of available chlorine. This is the oxidizing power of the solution measured by the ability of the solution to liberate iodine from an acidified iodide solution. One hypochlorite ion has the oxidizing power of 2 atoms of chlorine, i.e., one molecule of chlorine gas.

20 At lower pH levels, aqueous solutions formed by dissolving hypochlorite-yielding compounds contain active chlorine, partially in the form of hypochlorous acid moieties and partially in the form of hypochlorite ions. At pH levels above about 10, i.e., at the pH levels of the instant compositions, essentially all (greater than 99%) of the active chlorine is reported to be in the form of hypochlorite ion.

25 Those bleaching agents which yield a hypochlorite species in an aqueous solution include alkali metal and alkaline earth metal hypochlorites, hypochlorite addition products, chloramines, chloramines, chloramides, and chlorimides. Specific examples of compounds of this type include sodium hypochlorite, potassium hypochlorite, monobasic calcium hypochlorite, dibasic magnesium hypochlorite, chlorinated trisodium phosphate dodecahydrate, potassium dichloroisocyanurate, sodium dichloroisocyanurate, 35 sodium dichloroisocyanurate dihydrate, trichlorocyanuric acid,

1,3-dichloro-5,5-dimethylhydantoin, N-chlorosulfamide, Chloramine T, Dichloramine T, Chloramine B and Dichloramine B. A preferred bleaching agent for use in the compositions of the instant invention is sodium hypochlorite, potassium hypochlorite, or a mixture thereof.

Most of the above-described hypochlorite-yielding bleaching agents are available in solid or concentrated form and are dissolved in water during preparation of the compositions of the instant invention. Some of the above materials are available as aqueous solutions.

A majority of the above-described bleaching agents are dissolved in the aqueous component of the present composition. Others may appear in the form of suspended particles in the composition. Bleaching agents should be used in a sufficient amount to provide from about 0.2% to about 2.5% available chlorine by weight, preferably from about 0.5% to about 1.5% available chlorine, by weight of the total composition.

#### Polymeric Thickening Agent

The thickening agent in the compositions of the present invention is a cross-linked polycarboxylate polymer thickening agent. This polymer preferably has a molecular weight of from about 500,000 to about 5,000,000, more preferably from about 750,000 to about 4,000,000.

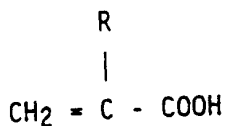
The polycarboxylate polymer is preferably a carboxyvinyl polymer. Such compounds are disclosed in U.S. Patent 2,798,053, issued on July 2, 1957, to Brown, the specification of which is hereby incorporated by reference. Methods for making carboxyvinyl polymers are also disclosed in Brown.

A carboxyvinyl polymer is an interpolymer of a monomeric mixture comprising a monomeric olefinically unsaturated carboxylic acid, and from about 0.1% to about 10% by weight of the total monomers of a polyether of a polyhydric alcohol, which polyhydric alcohol contains at least four carbon atoms to which are attached at least three hydroxyl groups, the polyether containing more than one alkenyl group per molecule. Other mono-olefinic monomeric materials may be present in the monomeric mixture if desired, even

in predominant proportion. Carboxyvinyl polymers are substantially insoluble in liquid, volatile organic hydrocarbons and are dimensionally stable on exposure to air.

Preferred polyhydric alcohols used to produce carboxyvinyl polymers include polyols selected from the class consisting of oligosaccharides, reduced derivatives thereof in which the carbonyl group is converted to an alcohol group, and pentaerythritol; most preferred is sucrose or pentaerythritol. It is preferred that the hydroxyl groups of the modified polyol be etherified with allyl groups, the polyol having at least two allyl ether groups per polyol molecule. When the polyol is sucrose, it is preferred that the sucrose have at least about five allyl ether groups per sucrose molecule. It is preferred that the polyether of the polyol comprise from about 0.1% to about 4% of the total monomers, more preferably from about 0.2% to about 2.5%.

Preferred monomeric olefinically unsaturated carboxylic acids for use in producing carboxyvinyl polymers used herein include monomeric, polymerizable, alpha-beta mono-olefinically unsaturated lower aliphatic carboxylic acids; more preferred are monomeric mono-olefinic acrylic acids of the structure



where R is a substituent selected from the group consisting of hydrogen and lower alkyl groups; most preferred is acrylic acid.

Various carboxyvinyl polymers are commercially available from B. F. Goodrich Company, New York, N.Y., under the trade name Carbopol®. These polymers are also known as carbomers or polyacrylic acids. Carboxyvinyl polymers useful in formulations of the present invention include Carbopol 910 having a molecular weight of about 750,000, Carbopol 941 having a molecular weight of about 1,250,000, and Carbopols 934 and 940 having molecular weights of about 3,000,000 and 4,000,000, respectively.

Preferred polycarboxylate polymers of the present invention are non-linear, water-dispersible, polyacrylic acid cross-linked

with a polyalkenyl polyether and having a molecular weight of from about 750,000 to about 4,000,000.

Highly preferred examples of these polycarboxylate polymers for use in the present invention are BASF Corporation's Sokalan PHC-25®, Polygel DK® available from 3-V Chemical Corporation, and the Carbopol 600 series resins available from B. F. Goodrich, especially Carbopol 614, 616 and 617. It is believed that these are more highly cross-linked than the 900 Carbopol series polymers and have molecular weights between about 1,000,000 and 4,000,000. Mixtures of polycarboxylate polymers as herein described may also be used in the present invention.

The polycarboxylate polymer thickening agent is preferably utilized with essentially no clay thickening agents since the presence of clay usually results in a less desirable product having phase instability. In other words, the polycarboxylate polymer is preferably used instead of clay as a thickening agent in the present compositions.

The polycarboxylate polymer thickening agent in the compositions of the present invention is present at a level of from about 0.1% to about 10%, preferably from about 0.25% to about 5%, most preferably from about 0.5% to about 2%.

In the preferred automatic dishwashing detergent composition, the polycarboxylate polymer thickening agent provides an apparent viscosity at high shear of greater than about 500 centipoise and an apparent yield value of from about 40 to about 800, and most preferably from about 60 to about 600, dynes/cm<sup>2</sup> to the composition.

Apparent viscosities at high shear are determined with a Brookfield RVT viscometer with spindle #6 at 100 rpm, reading the torque at 30 seconds.

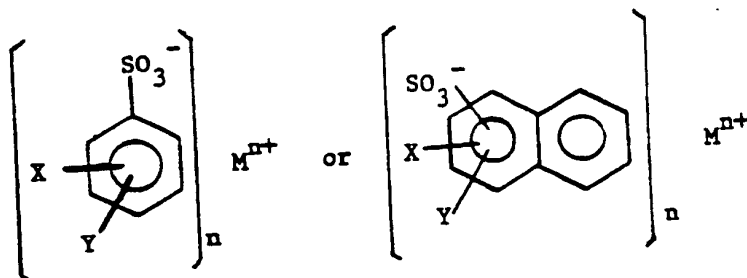
The yield value is an indication of the shear stress at which the gel strength is exceeded and flow is initiated. It is measured herein with a Brookfield RVT model viscometer with a T-bar B spindle at about 77°F (25°C) utilizing a Helipath drive during associated readings. The system is set to 0.5 rpm and a torque reading is taken for the composition to be tested after 30 seconds or after the system is stable. The system is stopped and

the rpm is reset to 1.0 rpm. A torque reading is taken for the same composition after 30 seconds or after the system is stable.

Apparent viscosities are calculated from the torque readings using factors provided with the Brookfield viscometer. An apparent or Brookfield yield value is then calculated as: Brookfield Yield Value = (apparent viscosity at 0.5 rpm - apparent viscosity at 1 rpm)/100. This is the common method of calculation, published in Carbopol® literature from the B. F. Goodrich Company and in other published references. In the cases of most of the formulations quoted herein, this apparent yield value is approximately four times higher than yield values calculated from shear rate and stress measurements in more rigorous rheological equipment.

#### Rheology Stabilizing Agent

The rheology stabilizing agents useful in the present invention have the formula:



wherein each X and Y is -H, -Cl, -Br, -SO<sub>3</sub><sup>-</sup>M<sup>+</sup>, -NO<sub>2</sub>, -OCH<sub>3</sub>, or -CH<sub>3</sub>, -CH<sub>2</sub>CH<sub>3</sub>, -CH<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>, -C(CH<sub>3</sub>)<sub>3</sub>, and M is H, an alkali metal, or an alkaline earth metal. Examples of this component include benzene sulfonic acid, naphthalene sulfonic acid, toluene sulfonic acid, and sodium xylene sulfonate.

Preferred rheology stabilizing agents of the present invention are benzene sulfonic acids, mono-substituted benzene sulfonic acids, and their salts.

Highly preferred examples of the rheology stabilizing agents useful in the present invention are benzene sulfonic acid, i.e., where X and Y and M are H; and toluene sulfonic acid, i.e., where X is CH<sub>3</sub>, and M and Y are H.



The cationic portion, M, is H, an alkali metal or alkaline earth metal cation, or mixture thereof. When M is H or an alkali metal cation, n is 1 and when M is an alkaline earth metal cation, n is 2.

It is clear that the present invention covers the acidic form of the species, i.e., M is H, as well as the salt derivatives thereof, i.e., M is an alkali metal or alkaline earth metal, preferably sodium or potassium. However, since the pH of compositions of the present invention are in the alkaline range, the rheology stabilizing agents exist primarily as the ionized salt in the aqueous compositions herein. In other words, although the rheology stabilizing agent may be added to the composition in its acidic form, it is likely to appear in the formula as a salt derivative. Mixtures of the rheology stabilizing agents as described herein may also be used in the present invention.

The rheology stabilizing component is present in an amount of from about 0.05% to about 5%, preferably from about 0.1% to about 2.0%, most preferably from about 0.2% to about 1%, by weight, of the composition.

Cross-linked polymers, especially those of high molecular weight, as used in the present bleach-containing composition, are vulnerable to bleach-initiated degradation and result in a loss of rheology that can be unacceptable for some applications. A certain small percentage of the chlorine bleach ingredient is present in solution in the form of a free radical, i.e., a molecular fragment having one or more unpaired electrons. These radicals, although short lived, are highly reactive and may initiate the degradation of certain other species in solution, including the cross-linked polycarboxylate polymers, via propagation mechanism. The polymers of this invention are susceptible to this degradation because of the presumed oxidizable sites present in the cross-linking structure.

A small addition of the benzene or naphthalene sulfonate rheology stabilizing agent described above substantially increases the physical stability, i.e., rheological stability, of the compositions of the present invention. Also provided is chemical stability of the chlorine bleach ingredient present in the

compositions of the present invention. Without wishing to be bound by theory, it is believed that the rheology stabilizing agent functions as a free radical scavenger, tying up the highly reactive species in the composition and preventing them from attacking the degradation-susceptible structure of the polycarboxylate polymers. Agents which stabilize the rheology of a composition by more rapidly consuming or reacting the free chlorine bleach are not functioning according to the invention herein.

Surprisingly though, other benzene and naphthalene sulfonates are ineffective as the rheology stabilizing agent in the present invention because they react with chlorine bleach or are unable to impede the interaction between the bleach ingredient and the polymeric thickening agent. This is true even though benzene sulfonates like sodium benzene sulfonate and sodium cumene sulfonate are generally disclosed together in the technical literature as hydrotropic agents.

One of the preferred rheology stabilizing agents herein is benzene sulfonic acid. However, cumene sulfonate ( $X$  is  $-\text{CH}(\text{CH}_2)_2$ ) does not function effectively as the rheology stabilizing agent. In fact, benzene sulfonates wherein  $X$  or  $Y$  is a secondary alkyl chain will not function effectively as rheology stabilizing agents in the compositions herein. On the other hand, benzene sulfonates wherein  $X$  or  $Y$  is a primary or tertiary alkyl chain do function effectively and provide the desired rheological stability.

#### Water

Compositions of the present invention contain at least about 5% water, preferably from about 15% to about 80% water, most preferably from about 30% to about 70% water, by weight of the composition. Water incorporated into the compositions is preferably softened or deionized.

#### Buffering Agent

In the instant compositions, it is generally desirable to also include one or more buffering agents capable of maintaining

the pH of the compositions within the alkaline range, determined as the pH of the undiluted composition ("as is") with a pH meter. It is in this pH range that optimum performance and stability of the bleach are realized, and it is also within this pH range wherein optimum composition chemical and physical stability are achieved.

Maintenance of the composition pH above about 10, preferably above about 11.5, minimizes undesirable chemical decomposition of the active chlorine, hypochlorite-yielding bleaching agents. Maintenance of this particular pH range also minimizes the chemical interaction between the strong hypochlorite bleach and the surfactant compounds present in the instant compositions. Finally, as noted, high pH values such as those maintained by an optional buffering agent serve to enhance the soil and stain removal properties during utilization of the present compositions.

Any compatible material or mixture of materials which has the effect of maintaining the composition pH within the alkaline pH range, and preferably within a 10 to about 13 range, can be utilized as the buffering agent in the instant invention. Such materials can include, for example, various water-soluble, inorganic salts such as the carbonates, bicarbonates, sesquicarbonates, silicates, pyrophosphates, phosphates, tetraborates, and mixtures thereof.

Examples of materials which can be used either alone or in combination as the buffering agent herein include sodium carbonate, sodium bicarbonate, potassium carbonate, sodium sesquicarbonate, sodium silicate, potassium silicate, sodium pyrophosphate, tetrapotassium pyrophosphate, tripotassium phosphate, trisodium phosphate, anhydrous sodium tetraborate, sodium tetraborate pentahydrate, potassium hydroxide, sodium hydroxide, and sodium tetraborate decahydrate. Combination of these buffering agents, which include both the sodium and potassium salts, may be used. This may include mixtures of tetrapotassium pyrophosphate and trisodium phosphate in a pyrophosphate/phosphate weight ratio of about 3:1, mixtures of tetrapotassium pyrophosphate and tripotassium phosphate in a pyrophosphate/phosphate weight ratio of about 3:1, and mixtures of

anhydrous sodium carbonate and sodium silicate in a carbonate/silicate weight ratio of about 1:3 to about 3:1, preferably from about 1:2 to about 2:1.

If present, the above-described buffering agent materials are dissolved or suspended in the aqueous component. Buffering agents can generally comprise from about 1% to about 25% by weight, preferably from about 2.5% to about 20% by weight, of the total composition.

### Detergent Surfactants

The compositions of this invention can contain from 0% to about 5%, preferably from about 0.1% to about 2.5%, of a bleach-stable detergent surfactant.

Desirable detergent surfactants, in general, include nonionic detergent surfactants, anionic detergent surfactants, amphoteric and zwitterionic detergent surfactants, and mixtures thereof.

Examples of nonionic surfactants include:

(1) The condensation product of 1 mole of a straight- or branched-chain alcohol or fatty acid containing from about 10 to about 20 carbon atoms with from about 4 to about 50 moles of ethylene oxide. Specific examples of such compounds include a condensation product of 1 mole of coconut fatty acid or tallow fatty acid with 10 moles of ethylene oxide; the condensation of 1 mole of oleic acid with 9 moles of ethylene oxide; the condensation product of 1 mole of stearic acid with 25 moles of ethylene oxide; the condensation product of 1 mole of tallow fatty alcohols with about 9 moles of ethylene oxide; the condensation product of 1 mole of oleyl alcohol with 10 moles of ethylene oxide; the condensation product of 1 mole of C<sub>19</sub> alcohol and 8 moles of ethylene oxide; and the condensation product of one mole of C<sub>18</sub> alcohol and 9 moles of ethylene oxide.

The condensation product of a fatty alcohol containing from 17 to 19 carbon atoms, with from about 6 to about 15 moles, preferably 7 to 12 moles, most preferably 9 moles, of ethylene oxide provides superior spotting and filming performance. More particularly, it is desirable that the fatty alcohol contain 18

carbon atoms and be condensed with from about 7.5 to about 12, preferably about 9, moles of ethylene oxide. These various specific C<sub>17</sub>-C<sub>19</sub> ethoxylates give extremely good performance even at lower levels (e.g., 2.5%-3%) and at the higher levels (less than 5%) are sufficiently low sudsing, especially when capped with a low molecular weight (C<sub>1-5</sub>) acid or alcohol moiety, so as to minimize or eliminate the need for a suds-suppressing agent. Suds-suppressing agents in general tend to act as a load on the composition and to hurt long term spotting and filming characteristics.

(2) Polyethylene glycols or polypropylene glycols having molecular weight of from about 1,400 to about 30,000, e.g., 20,000; 9,500; 7,500; 6,000; 4,500; 3,400; and 1,450. All of these materials are wax-like solids which melt between 110°F(43°C) and 200°F(93°C).

(3) The condensation products of 1 mole of alkyl phenol wherein the alkyl chain contains from about 8 to about 18 carbon atoms and from about 4 to about 50 moles of ethylene oxide. Specific examples of these nonionics are the condensation products of 1 mole of decylphenol with 40 moles of ethylene oxide; the condensation product of 1 mole of dodecyl phenol with 35 moles of ethylene oxide; the condensation product of 1 mole of tetradecylphenol with 25 moles of ethylene oxide; the condensation product of 1 mole of heptadecylphenol with 30 moles of ethylene oxide, etc.

(4) Polyoxypropylene, polyoxyethylene condensates having the formula  $\text{HO}(\text{C}_2\text{H}_4\text{O})_x(\text{C}_3\text{H}_6\text{O})_y(\text{C}_2\text{H}_4\text{O})_x\text{H}$  or  $\text{HO}(\text{C}_3\text{H}_6\text{O})_y(\text{C}_2\text{H}_4\text{O})_x(\text{C}_3\text{H}_6\text{O})_y\text{H}$  where total y equals at least 15 and total (C<sub>2</sub>H<sub>4</sub>O) equals 20% to 90% of the total weight of the compound and the molecular weight is from about 2,000 to about 10,000, preferably from about 3,000 to about 6,000. These materials are, for example, the Pluronic which are well known in the art.

(5) The compounds of (1) or (4) which are capped with propylene oxide, butylene oxide and/or short chain alcohols and/or short chain fatty acids, e.g., those containing from 1 to about 5 carbon atoms, and mixtures thereof.

Generally, useful surfactants in detergent compositions are those having the formula  $RO-(C_2H_4O)_xR^1$  wherein R is an alkyl or alkylene group containing from 17 to 19 carbon atoms, x is a number from about 6 to about 15, preferably from about 7 to about 12, and  $R^1$  is selected from the group consisting of: preferably, hydrogen, C<sub>1</sub>-5 alkyl groups, C<sub>2</sub>-5 acyl groups and groups having the formula  $-(C_yH_{2y}O)_nH$  wherein y is 3 or 4 and n is a number from one to about 4.

In addition to the above-mentioned surfactants, other surfactants useful in detergent compositions can be found in the disclosures of U.S. Patent Nos. 3,544,473, 3,630,923, 3,888,781 and 4,001,132, all of which are incorporated herein by reference.

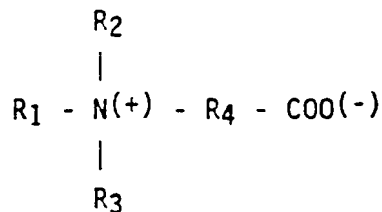
Since compositions of the invention herein contain a hypochlorite bleach, it is preferable that the detergent surfactant be bleach-stable. Such surfactants desirably do not contain functions such as unsaturation and some aromatic, amide, aldehydic, methyl keto or hydroxyl groups which are susceptible to oxidation by the hypochlorite. If such functions or groups are present in the surfactant, it is preferred that sufficient hydrophobic character be present therein to put the surfactant into a separated disperse phase in the aqueous composition.

Bleach-stable anionic surfactants which are especially resistant to hypochlorite oxidation fall into two main groups. One such class of bleach-stable anionic surfactants are the water-soluble alkyl sulfates and/or sulfonates, containing from about 8 to 18 carbon atoms in the alkyl group. Alkyl sulfates are the water-soluble salts of sulfated fatty alcohols. They are produced from natural or synthetic fatty alcohols containing from about 8 to 18 carbon atoms. Natural fatty alcohols include those produced by reducing the glycerides of naturally occurring fats and oils. Fatty alcohols can be produced synthetically, for example, by the Oxo process. Examples of suitable alcohols which can be employed in alkyl sulfate manufacture include decyl, lauryl, myristyl, palmityl and stearyl alcohols and the mixtures of fatty alcohols derived by reducing the glycerides of tallow and coconut oil.

Specific examples of alkyl sulfate salts which can be employed in the instant detergent compositions include sodium lauryl alkyl sulfate, sodium stearyl alkyl sulfate, sodium palmityl alkyl sulfate, sodium decyl sulfate, sodium myristyl alkyl sulfate, potassium lauryl alkyl sulfate, potassium stearyl alkyl sulfate, potassium decyl sulfate, potassium palmityl alkyl sulfate, potassium myristyl alkyl sulfate, sodium dodecyl sulfate, potassium dodecyl sulfate, potassium tallow alkyl sulfate, sodium tallow alkyl sulfate, sodium coconut alkyl sulfate, magnesium coconut alkyl sulfate, calcium coconut alkyl sulfate, potassium coconut alkyl sulfate and mixtures of these surfactants. Highly preferred alkyl sulfates are sodium coconut alkyl sulfate, potassium coconut alkyl sulfate, potassium lauryl alkyl sulfate and sodium lauryl alkyl sulfate.

A preferred sulfonated anionic surfactant is the alkali metal salt of secondary alkane sulfonates, an example of which is the Hostapur SAS from Hoechst Celanese.

A second class of bleach-stable surfactant materials operable in the instant invention are the water-soluble betaine surfactants. These materials have the general formula:



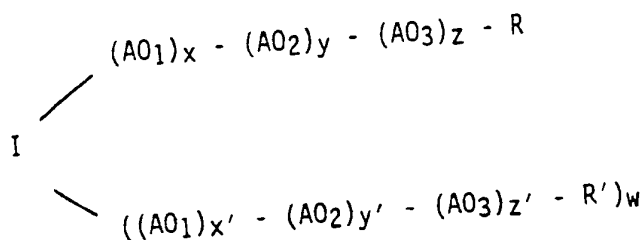
wherein R<sub>1</sub> is an alkyl group containing from about 8 to 18 carbon atoms; R<sub>2</sub> and R<sub>3</sub> are each lower alkyl groups containing from about 1 to 4 carbon atoms, and R<sub>4</sub> is an alkylene group selected from the group consisting of methylene, propylene, butylene and pentylene. (Propionate betaines decompose in aqueous solution and hence are not included in the instant compositions).

Examples of suitable betaine compounds of this type include dodecyldimethylammonium acetate, tetradecyldimethylammonium acetate, hexadecyldimethylammonium acetate, alkyl dimethylammonium acetate wherein the alkyl group averages about 14.8 carbon atoms in length, dodecyldimethylammonium butanoate, tetradecyldimethylammonium butanoate, hexadecyldimethylammonium butanoate,

dodecyldimethylammonium hexanoate, hexadecyldimethylammonium hexanoate, tetradecyldiethylammonium pentanoate and tetradecyldi-propyl ammonium pentanoate. Especially preferred betaine surfactants include dodecyldimethylammonium acetate, dodecyldimethylammonium hexanoate, hexadecyldimethylammonium acetate, and hexadecyldimethylammonium hexanoate.

Nonionic surfactants useful herein include ethoxylated and/or propoxylated nonionic surfactants such as those available from BASF Corp. of New Jersey. Examples of such compounds are polyethylene oxide, polypropylene oxide block copolymers sold under the trade names Pluronic® and Tetronic® available from BASF Corp.

Preferred members of this class are capped oxyalkylene oxide block copolymer surfactants of the following structure:



where I is the residue of a monohydroxyl, dihydroxyl, or a polyhydroxyl compound; AO<sub>1</sub>, AO<sub>2</sub>, and AO<sub>3</sub> are oxyalkyl groups and one of AO<sub>1</sub> and AO<sub>2</sub> is propylene oxide with the corresponding x or y being greater than zero, and the other of AO<sub>1</sub> and AO<sub>2</sub> is ethylene oxide with the corresponding x or y being greater than zero, and the molar ratio of propylene oxide to ethylene oxide is from about 2:1 to about 8:1; R and R' are hydrogen, alkyl, aryl, alkyl aryl, aryl alkyl, carbamate, or butylene oxide; w is equal to zero or one; and z, x', y', and z' are greater than or equal to zero.

Other bleach-stable surfactants include amine oxides, phosphine oxides, and sulfoxides. However, such surfactants are usually high sudsing. A disclosure of bleach-stable surfactants can be found in published British Patent Application 2,116,199A; U.S. Patent 4,005,027, Hartman; U.S. Patent 4,116,851, Rupe et al; U.S. Patent 3,985,668, Hartman; U.S. Patent 4,271,030, Brierley et



al; and U.S. Patent 4,116,849, Leikhim, all of which are incorporated herein by reference.

Other desirable bleach-stable surfactants are the alkyl phosphonates, taught in U.S. Patent 4,105,573, to Jacobsen, issued August 8, 1978, incorporated herein by reference.

#### Detergency Builder

Detergency builders are optional materials which reduce the free calcium and/or magnesium ion concentration in a surfactant-containing aqueous solution. In the preferred automatic dishwashing detergent compositions they are used at a level of from about 5% to about 50%, preferably from about 15% to about 40%. Generally the detergency builder used in automatic dishwashing detergent compositions like those of the present invention, is sodium tripolyphosphate in an amount from about 10% to about 40%, preferably from about 15% to about 30%. Generally a certain percentage of the sodium tripolyphosphate is in an undissolved particulate form suspended in the rest of the detergent composition. A phosphate ester, if present in the composition, works to keep such solid particles suspended in the aqueous solution.

The detergency builder material can be any of the detergent builder materials known in the art which include trisodium phosphate, tetrasodium pyrophosphate, sodium tripolyphosphate, sodium hexametaphosphate, potassium pyrophosphate, potassium tripolyphosphate, potassium hexametaphosphate, sodium silicates having  $\text{SiO}_2:\text{Na}_2\text{O}$  weight ratios of from about 1:1 to about 3.6:1, sodium carbonate, sodium hydroxide, borax, sodium nitrilotriacetate, sodium carboxymethyloxysuccinate, sodium carboxymethyloxymalonate, polyphosphonates, salts of low molecular weight carboxylic acids, and polycarboxylates, such as polyacrylates or polymaleates, copolymers and mixtures thereof.

Some of the above-described buffering agent materials additionally serve as builders. It is preferred that the buffering agent contain at least one compound capable of additionally acting as a builder.

### Alkali Metal Amphoteric Metalate

An optional component of the present invention is an alkali metal salt of an amphoteric metal anion, hereinafter referred to as a metalate. This component can provide additional structuring to the polycarboxylate polymer thickening agent in the preferred automatic dishwashing detergent composition.

The metalate in the automatic dishwashing detergent compositions of the present invention is present at a level of from 0% to about 1%, preferably from about 0.01% to about 0.1%.

The metalates of amphoteric metals, e.g., aluminum, zinc, beryllium, tin, zirconium, titanium, etc., will act similarly in the present invention to provide this polymer structuring benefit. These alternative metalates are intended to be covered by the present invention. A preferred metalate is potassium or sodium aluminate, e.g.,  $M_2O \cdot Al_2O_3 \cdot 3H_2O$ , where M is K or Na.

One method of incorporating the metalate into the preferred automatic dishwashing detergent composition is by dissolving or colloidally dispersing an amphoteric metal oxide into an aqueous alkali metal hydroxide in an amount equal to or greater than one molar equivalent of the hydroxide. Some metalates, such as sodium aluminate, are commercially available.

The metalate can be added into the composition at any point when the pH of the mixture is above about 10, preferably above about 11.5. A preferred method of incorporating the metalate into the preferred automatic dishwashing detergent composition is by blending the metalate into an aqueous solution of an alkali metal silicate and then incorporating the resultant colloid with other components of the automatic dishwashing detergent composition. The preferred structuring benefit is seen when the metalate is finely dispersed in the silicate such that very little or no increased turbidity is visible in the mixture.

Formulation of these compositions with a metalate such as aluminate assures that cationic metal ions such as  $Al^{+3}$  are not present to precipitate silicate under such mixing conditions.

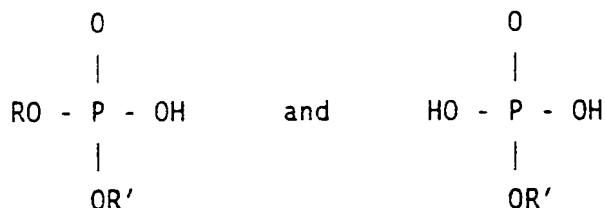
The lack of suspended or visible solids in this colloidal silico-metalate, i.e., particle sizes greater than about 1 micron,

allows for the finished composition to be a clear or translucent gel when sufficient potassium salts are used to ensure dissolution of other components, i.e., molar ratio of potassium to sodium ions greater than about 1:1, preferably greater than about 3:2.

From 0% to about 15%, preferably from about 3% to about 10%, on a solids basis, of the silico-metalate is added to the polyacrylate polymer thickening agent to get the additional structuring. The molar ratio of aluminum metal to SiO<sub>2</sub> in the preferred colloidal dispersion formed should be from about 0.01:1 to about 0.1:1, preferably from about 0.02:1 to about 0.06:1, to get the best structuring benefits.

#### Other Optional Materials

The compositions of the present invention may optionally comprise certain esters of phosphoric acid (phosphate ester). Phosphate esters are any materials of the general formula:



wherein R and R' are C<sub>6</sub>-C<sub>20</sub> alkyl or ethoxylated alkyl groups. Preferably R and R' are of the general formula: alkyl-(OCH<sub>2</sub>CH<sub>2</sub>)<sub>Y</sub> wherein the alkyl substituent is C<sub>12</sub>-C<sub>18</sub> and Y is between 0 and about 4. Most preferably the alkyl substituent of that formula is C<sub>12</sub>-C<sub>18</sub> and Y is between about 2 and about 4. Such compounds are prepared by known methods from phosphorus pentoxide, phosphoric acid, or phosphorus oxy halide and alcohols or ethoxylated alcohols.

It will be appreciated that the formula depicted represent mono- and di-esters, and commercial phosphate esters will generally comprise mixtures of the mono- and di-esters, together with some proportion of tri-ester. Typical commercial esters are available under the trademarks "Phospholan" PDB3 (Diamond Shamrock), "Servoxyl" VPAZ (Servo), PCUK-PAE (BASF-Wyandotte), SAPC (Hooker). Preferred for use in the present invention are

KN340N and KL340N (Hoescht) and monostearyl acid phosphate (Oxidant Chemical Corp.). Most preferred for use in the present invention is Hostophat-TP-2253 (Hoescht).

The phosphate esters useful herein provide protection of silver and silver-plated utensil surfaces. The phosphate ester component also acts as a suds suppressor in the anionic surfactant-containing detergent compositions disclosed herein.

If a phosphate ester component is used in the compositions of the present invention, it is generally present from about 0.1% to about 5%, preferably from about 0.15% to about 1.0%, by weight of the composition.

Metal salts of long chain hydroxy fatty acids have been found to be useful in automatic dishwashing detergent compositions to inhibit tarnishing caused by repeated exposure of sterling or silver-plate flatware to bleach-containing automatic dishwashing detergent compositions (U.S. Patent 4,859,358, Gabriel et al). By "long chain hydroxy fatty acid" is meant the higher aliphatic hydroxy fatty acids having from about 8 to about 22 carbon atoms, preferably from about 10 to 20 carbon atoms, and most preferably from about 12 to 18 carbon atoms, inclusive of the carbon atom of carboxyl group of the fatty acid, e.g., hydroxy stearic acid. By "metal salts" of the long chain hydroxy fatty acids is meant both monovalent and polyvalent metal salts, particularly the sodium, potassium, lithium, aluminum, and zinc salts, e.g., lithium salts of the hydroxy fatty acids. Specific examples of this material are potassium, sodium, and particularly lithium hydroxy stearate. If the metal salts of long chain hydroxy fatty acids are incorporated into the automatic dishwashing detergent compositions of the present invention, this component generally comprises from about 0.05% to about 0.3%, preferably from about 0.05% to about 0.2% by weight of the composition.

Conventional coloring agents and perfumes can also be added to the instant compositions to enhance their aesthetic appeal and/or consumer acceptability. These materials should, of course, be those dye and perfume varieties which are especially stable against degradation by high pH and/or strong active chlorine bleaching agents.

If present, the above-described other optional materials generally comprise no more than about 10% by weight of the total composition and are dissolved, suspended, or emulsified in the present compositions.

#### Process

Conventional methods can be used to prepare the liquid or gel cleaning compositions herein described. See, for example, U.S. Patents 4,824,590, Roselle, issued April 25, 1989; 5,053,158, Dixit et al, issued October 1, 1991; 4,970,016, Ahmed et al, issued November 13, 1990; 5,057,237, Drapier et al, issued October 15, 1991; 5,078,027, Dixit et al, issued December 24, 1991; and 4,941,988, Wise, issued July 17, 1990. A preferred method for preparing a final product of the present invention comprises:

- (a) mixing water and alkalinity buffering agent under low to medium shear rates;
- (b) adding builder;
- (c) adding a thickener slurry under medium shear until desired rheological properties are achieved;
- (d) adding surfactant and other suitable agents; and
- (e) adding chlorine bleach ingredient.

An alternate method comprises adding the thickening agent after step (d) but before adding the chlorine bleach ingredient. The thickening agent may be added as either a powder or slurry.

As used herein all percentages, parts, and ratios are by weight unless otherwise stated.

The following Examples illustrate the invention and facilitate its understanding.

#### Example I

Automatic dishwashing detergent compositions are as follows:

<u>Ingredient</u>	<u>% By Weight of the Composition</u>
Sodium tripolyphosphate (STPP)	4.67
Tetrapotassium pyrophosphate (TKPP)	12.60
Sodium silicate, 2.4 ratio	3.27

Potassium carbonate ( $K_2CO_3$ )	3.91
Sodium carbonate ( $Na_2CO_3$ )	2.61
Available chlorine (added as $NaOCl$ )	0.93
Potassium hydroxide (KOH)	0.84
Polyacrylic acid (Sokalan PHC-25)	1.26
Benzene sulfonate species (if present)	**
Trim KOH, to pH 12.2-12.3	0-0.3
Perfume, dye, trim water to 100%	Balance to 100%

Neat pH of Compositions 12.2-12.3

- 10 \*\* The benzene sulfonate species (if present) is incorporated in the detergent compositions on a equimolar basis. Therefore, the detergent compositions contain, by weight, 0% benzene sulfonate species, 0.73% p-toluene sulfonic acid, 0.79% sodium xylene sulfonate, 0.61% benzene sulfonic acid, and 15 0.85% sodium cumene sulfonate, respectively.

The polyacrylic acid is slurried into demineralized water at 3.4% by weight. All other ingredients are added in the following order while stirring with a paddle blade mixer: additional available trim water, TKPP as a 40% aqueous solution, and KOH (45% in water) , silicate as 47.3% solids in water, sodium and potassium carbonates and STPP as dry powders (essentially dissolved within five minutes), and the benzene sulfonate species (if present). The acids or anhydrides are neutralized by the excess caustic already present in the composition. Heat is added during mixing up to this point so that the mixture temperature is above about 130°F (54°C). This temperature is maintained at least five minutes to aid in sample equilibration. After the composition has cooled to about 90°F (32°C) or below, the aqueous sodium hypochlorite is added as approximately 13% available chlorine. 20 Optional perfume and colorants are added last. The composition is clear or translucent, with no visible particles or turbidity. Balance water is added, along with sufficient KOH trim to adjust the pH of the composition "as is" to 12.2-12.3, and further KOH trim is used if needed after overnight equilibration.

35 After about one to three days of equilibration, samples of the above composition exhibit an apparent Brookfield yield value

of about 250 to 450 dynes/cm<sup>2</sup>, an apparent viscosity at high shear (100 rpm, Brookfield RVT #6) of about 1300 to 4000 cps, and an apparent viscosity at moderate shear (20 rpm, Brookfield RVT #6) of about 4000 to 8000 cps.

Physical properties are recorded, and light-shielded bottled samples are placed in 100°F (38°C) and 120°F (49°C) and at ambient conditions. Brookfield apparent viscosities are determined with a Brookfield RVT model with #6 spindle at 100 RPM. In the rapid aging condition of 120°F (49°C), the following viscosity readings are taken at one-week intervals. The day following the making of the composition is the initial day.

Benzene Sulfonate Species	Initial Viscosity (Centipoise)	% of Initial Viscosity After:				
		1 Week	2 Weeks	3 Weeks	4 Weeks	6 Weeks
None	2400	107	*	*	*	*
p-Toluene sulfonic acid	2350	117	88	90	76	63
Sodium xylene sulfonate	2340	85	97	82	73	53
Benzene sulfonic acid	2120	116	124	100	82	*
Sodium cumene sulfonate	2680	87	51	34	22	*

\* Measured viscosity below 10% of initial or approaching water-thin by appearance.

At 120°F (49°C), compositions containing the rheology stabilizing agents toluene sulfonic acid, sodium xylene sulfonate, and benzene sulfonic acid (compositions within the scope of the invention herein) maintain at least 80% of their initial viscosity for 3.5, 3.5, and 4 weeks, respectively, and maintain 0.4% available chlorine in the compositions for 4, 2.5, and 4 weeks, respectively. Comparative compositions containing no rheology stabilizing agent, i.e., the composition containing no benzene sulfonate species and the composition containing sodium cumene sulfonate, maintain this viscosity level for only 1.5 weeks. Although the composition containing no benzene sulfonate species is able to maintain a 0.4% available chlorine level for 4 weeks, the composition containing sodium cumene sulfonate reaches this level after only 1.5 weeks. The results for the rapid aging

condition of 100°F (38°C) are consistent with those for 120°F (49°C).

Compositions of the invention herein, i.e., compositions containing a rheology stabilizing agent, display enhanced rheological properties compared to compositions containing no rheology stabilizing agent. Although the addition of the rheology stabilizing agents may result in an initial lower viscosity compared to the no-additive formula, a dramatically improved storage-stable formula is achieved.

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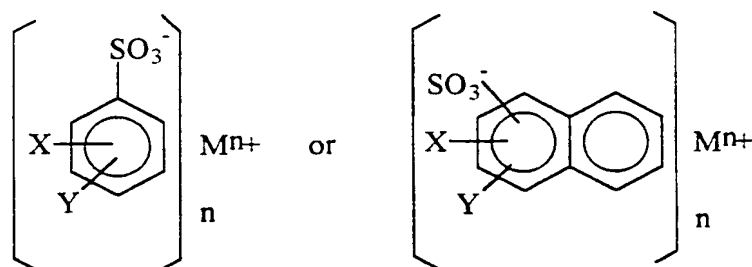
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## Claims

1. A liquid or gel cleaning composition comprising, by weight:
  - (a) a chlorine bleach ingredient providing from 0.2 to 2.5%, preferably 0.5 to 1.5% available chlorine;
  - (b) from 0.1 to 10%, preferably 0.5 to 2.0% of a cross-linked polycarboxylate polymer thickening agent;
  - (c) at least 5% water;
  - (d) sufficient alkalinity buffering agent to provide said composition with a pH greater than 10, preferably greater than 11.5; characterized in that it further comprises;
  - (e) from 0.05 to 5%, preferably 0.2 to 1.0% of a rheology stabilizing agent having the formula



wherein each X and Y is selected from -H, -Cl, -Br,  $-\text{SO}_3^- \text{M}^+$ ,  $-\text{NO}_2$ ,  $-\text{OCH}_3$ ,  $-\text{CH}_3$ ,  $-\text{CH}_2\text{CH}_3$ ,  $-\text{CH}_2\text{CH}_2\text{CH}_3$ , and  $-\text{C}(\text{CH}_3)_3$ , and mixtures thereof; M is selected from H, an alkali metal, an alkaline earth metal, and mixtures thereof; and n is 1 when M is H or an alkali metal, and n is 2 when M is an alkaline earth metal.

2. A composition according to Claim 1 wherein the composition is an automatic dishwashing detergent composition which additionally contains:
 

from 0% to 5%, preferably 0.1 to 2.5% of a detergent surfactant, preferably selected from capped propylene oxide, ethylene oxide block copolymers; condensation products of ethylene oxide and propylene oxide with a mono-, di-, or poly-hydroxyl compound with residual hydroxyls capped; alkali metal salts of mono- and/or di-( $\text{C}_{8-14}$ ) alkyl diphenyl oxide mono- and/or di-sulfonates;  $\text{C}_{8-18}$  alkyl sulfates;  $\text{C}_{8-18}$  alkyl sulfonates; and mixtures thereof;

from 5 to 50%, preferably 15 to 40% of a detergency builder material, preferably selected from alkali metal tripolyphosphate, alkali metal pyrophosphate, alkali metal silicates, alkali metal carbonates, polycarboxylates, and mixtures thereof.

3. A composition according to Claim 1 or 2 which additionally contains from 0% to 1%, preferably 0.01 to 0.1% of an alkali metal salt of an amphoteric metal anion, preferably selected from the group consisting of sodium or potassium aluminate, sodium or potassium zincate, sodium or potassium stannate (IV), sodium or potassium titanate (IV), and mixtures thereof; said composition having an apparent yield value of from 40 to 800 dynes/cm<sup>2</sup>.

4. A composition according to any of the preceding claims wherein the chlorine bleach ingredient is selected from sodium hypochlorite, potassium hypochlorite, and mixtures thereof.

5. A composition according to any of the preceding claims wherein the molecular weight of the polycarboxylate polymer thickening agent is from 750,000 to 4,000,000.

6. A composition according to any of the preceding claims wherein the rheology stabilizing agent is selected from benzene sulfonic acid, toluene sulfonic acid, xylene sulfonic acid, and salts and mixtures thereof.

7. A composition according to any of the preceding claims wherein the alkalinity buffering agent is selected from alkali metal silicates, alkali metal carbonates, alkali metal hydroxides, and mixtures thereof.

8. A composition according to any of the preceding claims comprising, by weight:

- (a) the chlorine bleach ingredient providing from 0.5 to 1.5% available chlorine;
- (b) from 0.5 to 2% of the cross-linked polycarboxylate polymer thickening agent;
- (c) from 0.2 to 1% of the rheology stabilizing agent;
- (d) from 0.1 to 2.5% of the surfactant; and
- (e) from 15 to 40% of the builder.

-26-

**Relevant Technical Fields**

(i) UK Cl (Ed.M) C5D (DEX, DHC, DHE, DHZ)

(ii) Int Cl (Ed.5) C11D 3/34, 3/37, 3/395

**Databases** (see below)

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASE:- WPI

Search Examiner  
JOHN WILSON

Date of completion of Search  
10 OCTOBER 1994

Documents considered relevant  
following a search in respect of  
Claims :-  
1-8

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